DOCUMENT RESUME

ED 051 548 EA 003 511

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TITLE Priority Determination and Resource Allocation by Planning-Programming-Budgeting and Cost-Effectiveness Analysis in Educational Systems.
PUB DATE Mar 69
NOTE 60p.; Paper is based on two previous papers: Miller, J. G., The Nature of Living Systems, Nov 68, and The Living Systems Involved in the Educational Process, Feb 69

EDRS PRICE EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS Budgeting, *Cost Effectiveness, Data Bases, Decision Making, *Educational Economics, Educational Objectives, *Information Systems, *Operations Research, Planning, Program Budgeting, Programing, *Resource Allocations, Simulation, Systems Analysis

ABSTRACT

A planning/programing/budgeting system and a cost-effectiveness analysis are complementary rather than opposing methods of operations research. The relative value of each process is dependent on the function each is to fulfill. The planning/programing/budgeting system is useful in determining educational objectives, developing programs to meet those objectives, and budgeting to satisfy the requirements of the programs. Cost-effectiveness analysis is useful for comparing alternative programs in terms of output per unit cost. Effective educational management demands an extensive, up-to-date information system for maximum utilization of any type of operations research. (RA)

ED051548

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PRIORITY DETERMINATION AND RESOURCE ALLOCATION BY PLANNING-PROGRAMMING-BUDGETING AND COST-EFFECTIVENESS ANALYSIS IN EDUCATIONAL SYSTEMS

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EA 003 511

March, 1969

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Excellence in education is determined by diverse, subtle, and interwoven factors, ranging from the morale of the institution's instructors through the familiarity of the faculty with current scholarly achievements to the warmth of food served in the cafeteria. These factors always are influenced by economic realities. With a given level of resources available, the task of school, college, or university administrators is to select the policies, people, facilities, and equipment that will give the students the "best and biggest education per buck." From this basic but limited view, education is essentially an economic choice in which educational effectiveness must be related to resources in short supply in order to attain specified purposes and achieve certain goals that help to attain them.

The History of Programming-Planning-Budgeting

Pioneer work in analyzing large and complex systems with interacting technical, social, and political variables from an economic standpoint was done by Charles J. Hitch and his associates. He was

*This paper is based on two previous papers on general systems theory and its applications to educational processes: (1) Miller, J. G. The Nature of Living Systems, November, 1968, and (2) Miller, J. G. The Living Systems Involved in the Educational Process, February, 1969.

once head of the Economic Division, the RAND Corporation, later was Assistant Secretary of Defense (Controller), and is now president of the University of California. The concepts of program budgeting* (also called programming-planning-budgeting or PPB) which he advanced are now used by the United States Department of Defense and by contractors doing work for that department. These concepts also are relevant to problems which arise in educational decision-making. The following quotation from Hitch states his basic assumptions: "...being truly economical does not mean scrimping--reducing expenditures no matter how important the things to be sought. Nor does it mean implementing some status doctrine regardless of cost. Rather economics is concerned with allocating resources--choosing doctrines and techniques so as to get the most out of available resources. To economize in this sense may imply spending less on some things and more on others. But always economics or economizing means trying to make the most efficient use of the resources available in all activities in any circumstance."[1]

In the military, as in educational and many other governmental institutions, classical forms of budgeting are usually not carried out in a way most conducive for the planning of future programs. Tradition, state statutes, and other considerations cause most educational budgets to be broken down into such categories as academic personnel, nonacademic personnel, fringe benefits, equipment, supplies, travel, capital

*Cf. Miller, J. G. The Nature of Living Systems, Op. cit., pp 45-46.

construction, and so forth. And it may be necessary to continue to use budget categories that are acceptable to state auditing, accounting, and budgeting officials as well as the relevant legislative bodies. But educational institutions may well conclude that they will benefit from using PPB in addition, as was done in the Department of Defense at Hitch's instigation. He said that the chief officials of his department "...were convinced that the financial management systems must also provide the data needed by top defense management to make the really crucial decisions, particularly on the major forces and weapons systems needed to carry on the principal missions of the defense establishment. And we were well aware that the financial management system, as it had evolved over the years, could not directly produce the required data in the form desired. It was clear that a new function, which we shall call programming, would have to be incorporated in the financial management systems....

"But the existing budget structures serve some very useful purposes. It is organized, essentially, in terms of resource categories: (1) Military Personnel; (2) Operation and Maintenance; (3) Procurement; (4) Research, Development, Tests and Evaluation; and (5) Military Construction....

"This division of the budget by broad input or resource categories provides needed flexibility for the adjustments in the program that are invariably required in the course of the budget year." But it was not the ideal form for program planning. Therefore

a new form of planning, programming, and budgeting was developed.

Identifying and Categorizing Programs

Continuing to refer to the application of these methods to the Department of Defense, Hitch states that the problem"...was to sort out all of the myriad programs and activities of the defense establishment and regroup them into meaningful program elements, i.e., integrated combinations of men, equipment, and installations whose effectiveness could be related to our national security objectives. These are the basic building blocks as well as the decision-making levels of the programming process. As I noted earlier, the B-52 bomber force, together with all of the supplies, weapons, and manpower needed to make it militarily effective is one such program element. Other examples are Attack Carriers, F-4 Fighter Wings, the Manned Orbiting Laboratory development project, and Recruit Training. Wherever possible program elements are measured in physical terms such as numbers of aircraft per wing, numbers of operational missiles on launchers, numbers of active ships, and so forth as well as in financial terms, thus including both 'inputs' and 'outputs'--costs and benefits. Of course, such program elements as research projects can only be measured in terms of inputs."[2]

Sometimes in the military a program is a componen·. Rarely it is a subsystem. Often it is an abstracted system. It may be the development and operation of a concrete system like a missile, a battleship, or a national air attack warning system.

At other times it is an abstracted system such as the total Navy personnel procurement activities, all recruit training, or the intelligence-gathering functions.

What Hitch noted about defense programs is equally true about educational programs: "We recognized from the beginning that the defense program is extremely dynamic and that changes would be required at various times during the year. Accordingly, we established a formal program change control system."[3]

And he also noted that: "To facilitate the conversion of program costs to the budget and vice versa, we also had to break down the costs of each program element by the various budget appropriation accounts in which it is financed. Operating costs typically are financed in the 'Military Personnel' and'Operation and Maintenance' appropriations and, where operating spares are involved, in the 'Procurement' accounts as well. Initial investment costs typically are financed in the 'Procurement' and 'Military Construction' appropriations.

"...The entire program is subject to continual change and is, therefore, updated every other month. Whenever a change is made in the cost of a program element in the current fiscal year, it must also be reflected in the budget for the same year and vice versa. Considering the vast quantities of data involved in the planning-programming-budgeting system, the only practical solution was to transfer the entire operation to a computer system. This we have now accomplished.

"The next task was to relate the program elements to the major missions of the Defense Department. The objective here was to assemble related groups or program elements that, for decision purposes, should be considered together either because they supported one another or because they were close substitutes. The unifying principle underlying each major program is a common mission or set of purposes for the elements involved. We now have nine major programs:

1. Strategic Retaliatory Forces
2. Continental Defense Forces
3. General Purpose Forces
4. Airlift and Sealift
5. Reserve and Guard
6. Research and Development
7. General Support
8. Retired Pay
9. Military Assistance."[4]

Also Hitch observed that there was "...need for military-economic studies which compare alternative ways of accomplishing national security objectives and which try to determine the way that contributes the most for a given cost or achieves a given objective for the least cost. The extensive and comprehensive use of these 'cost-effectiveness' studies or systems analyses was the second major innovation introduced into the decision-making process of the Defense Department."[5]

"Virtually every attempt we have made to explain the inexorable logic of relating cost to military effectiveness seems to shatter itself on the argument--'Nothing but the best will do for our boys.' And the 'best' usually refers to some particular characteristic of physical performance, such as speed, altitude, or firepower, or even unit cost!

"Implicit in this challenge is the deeply rooted feeling that national defense is far too important a matter to be inhibited by cost. If one weapon system performs better than another, then we should buy the higher performance system, regardless of cost; the country can afford it. Indeed, the people who hold this view feel that it is somehow sinful, or at least unpatriotic, to try to relate performance or military effectiveness to costs; that considerations of military effectiveness and cost are antithetical."[6]

It would not be hard to find educators, in some of the nation's best country day schools, in the high schools of some of our wealthiest suburbs, in Ivy League colleges, and in a few of the most privileged state universities, who hold the same view about education. But realistically we can no longer hope to finance such a policy anywhere. Modern education is inherently too complex and the demand for primary, secondary, and higher education is too widespread in the society. Too great a proportion of the gross national product would go to education, leaving unmet other competing demands for other socially worthy purposes as, e.g., housing, highways, urban renewal, health, mental health, and

welfare. We must look for educational innovations which will maximize quality and minimize costs, and we must have an accurate idea of the productivity and expenses of any educational program we undertake. The first major use of PPB, as we have indicated, was in the Department of Defense beginning in 1961. Since that time it has been designated as the official method for all budgeting in the federal government, the State of California, and other political jurisdictions. While the inertia of such huge governmental budgeting apparatuses has not yet wholly yielded to PPB, it appears to be just over the horizon for much if not all of public sector fiscal management, including that of educational institutions.

The Fundamental Principles of PPB

PPB, according to Jungherr, is "...aimed at helping management make better decisions on the allocation of resources among alternative ways to attain government objectives. Its essence is the development and presentation of relevant information as to the full implications--the costs and benefits--of the major alternative courses of action."[7] The chief steps in its use are as follows:

1. Identify the main purposes and goals of the educational institution.
2. Identify programs which are directed to achieving these purposes and goals, and alternative programs which might do so.

3. Identify all processes or activities, regardless of where in the system they are or would be located, which contribute to these programs.

4. Consider the likely development of these programs in future years.

5. Calculate all related costs.

6. Select among possible alternative programs in terms of their costs and benefits.

To implement PPB budgeting, the executives who carry out the decision-making begin by agreeing on the ultimate purposes of their organization. If purposes are wrongly selected or described, the analysis will go wrong. For example, if it is assumed that the only purpose of a physical education program is to build strong bodies and the development of individual initiative is neglected, the allocation of resources is not likely to be optimal. Then the deciders must state operationally what goals must be attained to achieve the purposes they have selected. In other words, "to provide a college education to qualified students" is certainly a purpose of any university, but it is not an operational statement of a goal. The questions "What is a college education?", "What does it mean to provide a college education?", "Who are qualified students?", and so forth, are not explicitly resolved. An example of an operational statement of a goal might be "This university intends to provide the faculty and the supporting staff and facilities necessary to enroll at least 95 percent of all applicants who have the admission requirements and

who wish to be trained as engineers in a curriculum as prescribed in our catalog, and at least possible cost."

After defining a set of operational goals, the decider or deciders or the staff propose possible programs which would carry the organization toward the achievement of its goals. If a goal is teaching engineers as suggested above, then various alternative engineering curricula would be proposed as possible programs. This can be the most creative and innovative stage of PPB development. New uses of instructional technologies can be proposed. The PPB procedure does not ignore the reality of how hard it is to change traditional modes of operation. Rather, it attempts to choose the "best" program. PPB forces all present and potential alternatives into competition. The result of this is both the "best" program or programs, according to the criteria established by the goals, and the costs of not pursuing the "best" alternative become recognized. This procedure does not insure that the "best" procedure will be implemented, but it does give the decider new and additional information. Often, new and unique alternatives are conceived and found feasible; a different combination of existing programs proves to be more desirable; or, at the very least, the costs of following and not following the current mode of operation are explicitly identified.

In education a program may be a concrete system like an Institute of Urban Studies in a university or an abstracted system like a preschool training program or a program for improving reading of children in the elementary grades.

Once a set of programs which are capable of achieving the desired institutional goals are chosen, the budgeting phase begins. A program budget may include both a set of indicators of the activities involved (e.g., the number of students, the number of faculty and staff, the amount of physical space, etc.) and the fiscal reflection of these physical activities (e.g., faculty salaries, support costs, research costs, administrative costs, etc.). All costs directly associated with an activity are listed under that activity. Those costs which are indirectly attributable to several activities should be allocated appropriately among them. In the case in which a cost cannot be assigned at all, a supporting or secondary program (in essence a dummy program) is sometimes included--an abstracted subsystem or component. All these indicators and costs are then extrapolated for a number of years into the future--say, three, five, or ten--to gain a systems-wide perspective of dynamic change over time.

The implementation of a PPB system is often a difficult and arduous task requiring a large data base. Since the information gathered by a traditional accounting system is usually oriented toward a traditional fiduciary-type budgeting system, an early prerequisite of a meaningful and operational program budget is an extensive and properly designed management information system. With it a simulation model of the educational organization can be constructed and consulted when institutional decisions are made. The field of simulation is new and can become much more sophisticated than it is today. Even though most simulations are still quite primitive, and they are used in only a few educational organizations, a well constructed simulation model provides significant advantages to academic administrators. It would be an extremely time-consuming and laborious task to calculate by hand all

the essential variables in an adequate PPB array. But once the output routine of the simulation model is programmed, an analyst can feed data from the management information system data banks into it and produce a program budget display in a few minutes of running time on a computer. Planners and administrators are enabled to consider a large number of alternative program proposals or proposed changes to existing programs with relatively little effort.[8]

"In order to choose one alternative over another one we must have a 'best' or criterion. The central problem in many economic choices is selecting an appropriate economic criterion. In industrial situations the criterion may usually be taken as profit optimization. In educational situations, however, the positive values (objectives) and the negative values (resources used up) seldom have a common measure. In addition, there may be multiple objectives which even among themselves have neither common units of measurement nor comparable costs. In most educational analyses we have to be satisfied with some approximation of the ideal criterion.

"To sum up, the educational planning activities must be placed in the context of economic choice. This does not mean that analytic aids or computing machines must be used for every problem. What it does mean is that economic choice is a way of looking at educational problems."[9]

Let us now look in more detail at the technique of PPB as applied to a series of different types of educational systems--all

of them at the organization level or above.

Determination of the System's Purposes and Goals

Precise descriptions of what the system is, what its environment is, and what its suprasystems and subsystems are, are prerequisites in any systems analysis. One must then determine the major dimensions or variables by which the system can be described and how they can be measured. Then one can proceed to discovering its purposes and goals.

For an educational system these can be established in two chief ways. The suprasystem may specify what they shall be, or they may be evolved internally by the system itself--though never, of course, without interactions with its suprasystem.

What purposes can a university have--to take one type of educational institution as an example? One class of purposes may be to meet demands of the community and society of which it is a part, its suprasystem. A university graduates educated ladies and gentlemen. Or perhaps it produces married, socialized ladies and gentlemen, which is a different thing. Perhaps it graduates useful citizens, or contributing workers. Perhaps it produces leaders, who, instead of conforming to the society, irritate it and its establishment. Maybe the purpose of the university is to achieve a proper conformity-innovation ratio between the university and the society, and perhaps universities are, therefore, always out-of-phase with society. The hope of somehow getting the university to conform to its environment may be mistaken, because any organization that leads, by definition,

cannot so conform. Perhaps the main purpose of a university is to produce ideas. Perhaps the university meets the special demands of the trustees or regents, the alumni, the parents, the government, or the church.

The university may strive to meet internal goals. These may be intellectual--to improve the accuracy, speed, or completeness of its information flow; to maximize the cost-effectiveness ratio of its information flows or matter and energy flows; to speed the rate of learning of the average student, the best student, or the minimal student; to increase the generality of students' learning or the depth of their specialization; to increase the number of scholarships or amount of research; or to raise the amount of faculty time devoted to teaching. Or the internal goals may be social--to increase the time students spend with people in the university who are known personally to them, or the number of student-faculty contacts, or the number of student-student contacts. Perhaps a goal of the university is to improve the careers and increase the convenience of the faculty, and this goal should not be discarded out of hand, since the institution that neglects it entirely cannot keep its faculty.

Obviously these goals conflict in many ways. Any one of them can be maximized or minimized, and each of them has its costs. Until purposes and goals are made specific, performance criteria cannot be rationally established, and decisions as to allocation

of personnel, effort, and time will be largely arbitrary. Any institution's goals, of course, must constantly be re-evaluated.

Three major techniques may be employed to discover and measure an educational institution's purposes or goals. These are: First, interviewing persons in the system, including leaders and followers, to find what they believe the system goals are. Second, observing how people actually behave in the system, so that one may infer what their goals seem to be. Third, studying documents, both private and public. Each method permits some quantification, enabling one to count the number of persons supporting various views of their organization's purposes and goals.

Classifying and Operationalizing the System's Purposes and Goals

The goals of an institution may be classified into those of the trustees or the school board, those of the administration, those of the teachers or faculty, those of the students, and those of the parents and other citizens of the community. But the executives usually make the final decisions, and their views therefore become the primary determiners of action.

Some goals may relate to the objective excellence of education or the breadth of the population educated or the effectiveness of the research carried on. Some of the goals are much more personal, such as achieving prestige, enjoyment, or satisfaction at being in an advanced educational system, or at having a special degree of communication among the students. Whatever it is, to

operationalize a goal there must be at least one precise measure of how nearly it is achieved. There exist proximal measures of achievement of goals and distal measures of accomplishment of purposes. Cost-benefit analysis uses distal or ultimate measures. These are generally difficult to define and to operationalize. An educational system strives for development of citizens, scientists, and other contributors to society. Measures of such accomplishment are distal or ultimate criteria. Cost-effectiveness analysis in educational systems, on the other hand, is in terms of proximal goals like the number of students accepted, the number of students graduated, or the number of papers written by the faculty. They are much easier to measure but far from ultimate.

Techniques for Deciding on Priorities Among Programs

Priority determination in an educational system is the process of deciding which set of programs should be implemented and in what order. Analytical and cost-effectiveness techniques suggest the best alternatives to an administrator, committee, or board. They should always make the final decision. Even though a majority of the time one might accept the analytical decision, the final human evaluation can avoid some gross errors.

Six techniques used for establishing priorities among programs are:

1. Analogy. In a recent study carried out for a technical school, the problem was posed of how to evaluate, within a very short

time, different possible physical plant designs. A quick review showed that the main inputs into the school were students who paid their own tuition at the rate of a good private university and engineers who were recruited from industry to do the teaching. Both these groups had to be attracted to keep the school operating. The outputs were students trained and ready to work in industrial settings. This suggested that the physical plant should look like a modern engineering laboratory--for the students come because they feel that it will prepare them for the work they desire. It should not seem like more nonvocationally oriented education. If engineers are to transfer from engineering to teaching, they must feel that the new environment will be as acceptable as the environment they are leaving. The future employer must believe that the school's training will transfer to his business. If he sees in the school a plant like that in which the student will work, he will be more assured that the training will transfer. This analogy can serve as a basis for evaluating plant design alternatives. Should this school have air conditioning? The answer is "yes." Modern engineering laboratories have air conditioning. Should the faculty be given individual offices? The answer is "no," because engineers typically do not require individual offices. Engineers do not punch time clocks, so the faculty should not be required to punch time clocks either.

2. Checklist. A checklist for rating a program is constructed on the assumption that all its items are weighted equally and that one can determine priorities or make choices among alternate programs

seeing how each program scores on the checklist. Individual judges or panels of judges rating independently, may use checklists. The latter procedure of pooling judgments of individuals scoring independently may improve the rating process.

3. Weighted techniques. Weighted techniques involve the assigning of weights to items on a checklist. This may be done by multiple correlation techniques, regression analysis, or negotiation among judges or decision-makers.

4. Cost-effectiveness or cost-benefit ratios. This is a mathematical approach to the setting of priorities among programs which has been popular in the aerospace industry. Priority is given to the program with the highest cost-effectiveness ratio (E) calculated as follows:

$$E = \sum_{i}^{n} \frac{(P_i \times U_i)}{C_i},$$

where P = probability of the i item occurring

U = utility of the i item if it occurs

C = cost of the i item

i = 1,2,3...N Number of alternatives or components.

5. Mathematical models. Many mathematical models exist that may be used to evaluate alternatives if problems can be mathematically formulated, mathematical conditions are met, and the solution can be computed. These models come from operations research.

6. Simulation. Simulation techniques, especially those which use digital computers, can compare the relative effectiveness of various educational systems. Special computer languages such as Simscript and GPSS aid the programmer in efficiently carrying out his simulations.

Measures of Benefits or Effectiveness

If cost-benefit or cost-effectiveness analysis is to be used in studying educational systems, the first step is to produce satisfactory measures of benefits or effectiveness. These include:

A. Measures of population saturation. The contributions of any educational system increase as the percentage of its students that it influences increases. To measure such influence one starts with a description of the input population and some index of their levels of achievement. The range of types in the population is also an important variable because an effective educational process should influence as many types as possible. Knowing the percentage of the student population which can be trained by any technique is important. If 30 percent of the students in a course have a certain level of achievement on the first day and at the end of the course 90 percent have reached that level, the class appears to be effective. On the other hand, if a course starts with 85 percent of the students at a given level of achievement and ends with 90 percent at that level, one questions its value.

B. Measures of achievement. These include standardized measures which allow one to compare an individual's or a group's degree of achievement to that of a normative population, as well as measures by which one compares the achievements of an individual or group at time "a" and at time "b". Both of these are important in educational evaluation. Among such achievement measures are:

1. Cognitive tests. These evaluate thinking processes in many fields, such as mathematics.

2. Affective tests. These measures of emotional adjustment include projective techniques, situational tests, and other procedures.

3. Social tests. These include attitude scales, observations of behavior in new situations, and sociometric measures. They measure the relationships among persons, for example, whom students select as partners in play.

4. Value internalization measures. Values are difficult to measure partly because they are hard to describe. Attitude studies, interviews, and situational measures are used. Some such tests measure the degree to which a student accepts cultural norms--attitudes toward cheating, for example.

5. Physical measures. Physical condition and achievement are easy to measure, by physical examinations and by tests of muscular strength and skill, athletic ability, and manual dexterity.

C. Measures of social benefits. Education influences the productivity of groups, organizations, and societies as well as individuals. Such measures as company productivity or gross national product or productivity per worker hour can be interpreted (with great caution) as indices of social benefits from education.

D. Critique of these measures. Anything as subtle and many-faceted as educational effectiveness is most difficult to measure with any validity. All single or joint measures so far proposed are primitive, and only partially valid. Furthermore, there are many pitfalls in the field of measurement. On the one hand, one is tempted to accept the newest measures because of their convenience and availability. On the other hand, one may develop, at much effort, a measure for a special purpose and then become

committed to it because of effort devoted to its development. Some tests have low reliability. Others are not valid. For some there are no norms. The cognitive and physical variables are relatively easy to measure and noncontroversial. On the other hand, some measures are hard to standardize, like most exams which teachers give. Yet they are helpful because they are often precisely directed toward the objectives of the education. A total evaluation of the benefits of an educational experience should take this whole range of variables into consideration. An example of this is Project Talent, which in 1960 tested 440,000 American high school students with aptitude, achievement, and information tests. It is important in measuring educational effectiveness to pay attention to accepted considerations of test development and psychometrics--the reliability and validity of the measures used, and the overall dimensionality of the domain of effectiveness, as determined by factor analytic or related methods.

Measure of Costs

In cost-benefits or cost-effectiveness studies it is essential to measure not only benefits and effectiveness but also costs. Such measurement deals with several sorts of costs.

A. Matter-energy, information, and time.

Money is a particular form of information which circulates throughout the society and is widely accepted as the common denominator of all costs. Therefore it may be used to measure many aspects of an

educational system, but there are other key resources in a community where expenditure involves cost. These include materials for buildings, gas, and electricity, and is another valuable commodity which cannot be, in many cases, completely translated into money. There are scarce human resources, valuable no matter how much money exists. The number of Ph.D.'s in the United States, for instance, is in short supply and is not going to change radically for years. Their time is a national shortage. Expenditure of anything which is scarce--matter, energy, information, or time--is a cost. In cost analysis indirect informational effects, such as on prestige or political power, must also be considered.

B. Human effort.

1. Student time and effort. Student time expenditure is a major consideration in resource allocation in an educational system. Students are available only a limited number of hours a week and this time must be used optimally. Measurement of students' time has usually been done in units of scheduled hours. Cost of student activity may be viewed in other ways. Older students, especially in agricultural regions and other communities where the students contribute significantly to local income, can have their class time measured in terms of their hourly earning power. Another approach is to analyze the alternative costs to society of student time in an educational institution as opposed to time in the army or time when they are unemployed and require, consequently, additional police, judicial, and correctional facilities.

2. Teacher and faculty time and effort. In recent years, effort reporting of faculty has been a key issue in many schools, colleges, and universities. The issue of measurement of work has been the subject of many controversies ever since the introduction of industrial engineering. The same basic units of time may be used to describe teachers as students, that is the working hour, or module in the case of the schools which can operate on a modular basis. Effort reporting has been done by using sheets in which one fills out how one spent his time, by sampling and observation, by the prescriptions of curriculum committees and supervisory personnel, or by estimates by supervisors. Direct observation is the best measure and the most difficult to arrange. There are also unobtrusive possible measures such as the use of substitutes, the number of recess periods, the amount of audiovisual aids used, or the number of trips to the library. Such indices sample teacher behavior and suggest how teachers expend their efforts.

3. Administrative or technician time and effort. The technical problems of measuring administrative or technician problems are similar to that of teachers and faculty, but there are not as many professional or status problems involved. Office or technical personnel, except in the top echelons, can be required to keep time records and in many cases they punch a time clock.

C. Monetary costs.

1. Short run. Capital expense cash flows have to be controlled but usually the long-term availability of capital is known and can be planned for. Accounting for short-term costs is also well understood and in general straightforward. Most of the commitments in an educational institution involve salaries. These are committed generally through a contract and so vary little within any year. The most difficult problems in short-run cost accounting concern the allocation of overheads.

2. Long run. (a) Capital. Long-term capital costs involve three issues. The first is the time value of money, which is a standard investment question. The second is depreciation. The third is the problem of raising the necessary money by levies, bonds, or private gifts. Certain forms of long-term financing may be economical from a short-run cost viewpoint but have a direct effect on the ability to borrow more money at a later date, which may make their use inadvisable. (b) Operating activities on a long-run basis. Operating activities in the long range must consider service, inflation, and consequent increased personnel, equipment, and supply costs.

Cost-Effectiveness Measures

Having measured both costs and benefits or effectiveness, one proceeds to compare educational programs in terms of their cost-benefit or cost-effectiveness ratios. We have already discussed

these ratios (see page 18), along with the mathematical models and simulation procedures which can aid in the process of selecting among alternative educational programs. An example of how the costs and the effectiveness of achieving a particular goal--in this case instruction tailored to individuals--must be weighed against each other is given in the following quotation from a report of the Committee for Economic Development:

"Individualized instruction, geared to the individual's interests, abilities, and learning rate, is one of the cherished goals of American education.... Yet the schools are making very slow headway in this direction through present means, principally through efforts to reduce the pupil-teacher ratio. Over the past decade, while the nation has increased its annual expenditures for its public schooling from about three percent to nearly four percent of the gross national product, there has been a reduction of only three pupils in the average class size of elementary schools. To achieve any fundamental reduction in average class size, while maintaining the traditional instructional practices, would...put a serious drain on the trained manpower of the country and raise the costs of staffing the schools to unacceptable levels.

"More important, we question whether the pupil-teacher ratio provides an adequate basis for determining educational policy. We believe that the key to achieving effectiveness in education lies in increasing the productivity of the individual teacher, and that the means are now available through...the

reorganization of instruction, the redesign of curricula, improved and new audiovisual methods, and the improvement of teacher education.

"What will these and other innovations cost in relation to the benefits they secure? Fortunately, new ways of measuring, testing, and assessing effectiveness and efficiency in education are being developed. Techniques of cost-effectiveness analysis and systems analysis, when used in the broadest sense, can now be employed in assessing the efficiency of school management. Moreover, research in the methods of measuring intellectual growth and attitudinal changes promises to increase the capability to evaluate a school's educational effectiveness. Although there are numerous imponderables in education that cannot be quantified or measured, we believe that these t chniques will assist the schools in setting priorities and designing programs....

"Any spending proposal, such as raising the starting salaries of teachers, could be assessed against the other possibilities for spending the same amount of money--e.g., determining what this sum would purchase if spent on such programs as the retraining of teachers. It would remain a matter of judgment whether the benefits of spending the money on retraining teachers would outweigh the benefits of improved recruitment. The choice among such alternatives would involve many factors, as for instance the policies and bargaining power of teachers' organizations. But however difficult the cost-benefit analysis when such factors are included, it should always be in the picture.

"Program accounting encourages school authorities to make useful comparisons of this kind. Perhaps most importantly, program accounting encourages the forecasting of the costs of new programs over a period of years. Grievous mistakes have been made in failing to take account of the cost in future years of programs that were superficially attractive but proved eventually to be bad educational investments.

"Program accounting will be particularly valuable in comparing the benefits that may accrue from other forms of resource allocation lying outside the scope of this statement. We have in mind the possibility, now being explored in various parts of the country, of gaining efficiency in the use of school facilities through their use after hours for adult education or other programs, or through the lengthening of the present school year, a legacy of the nation's agrarian past....Program accounting will assist decision-making by providing comparisons that take into account the various costs involved in such proposals as against alternative costs accruing, for example, from plant expansion to provide for new pupils." [10]

Computerized Management Information Systems and PPB

As we have indicated above, the management of any educational system needs extensive and up-to-date information before the decisions which are inherent in PPB can be made. This, in most organizations

of any size, today requires a computerized management information system.

A. How to build and operate one. A computerized management information system should be the product of a systems analysis which determines whether such an aid to decision-making is needed and what type is required. Automation is not a panacea. It has a place in many organizations. Bad automation is worse than a poor manually run system. People are usually able to adjust and correct human errors. A computerized system is not so adaptive.

The development of an automated management information system follows decisions made in systems analysis. One must specify what types of data to process, who will receive the information outputs, what information flow rates will be involved, what the costs will be, how confidentiality of information will be maintained, and other requirements.

B. Establishing a data gathering system. It is necessary to specify how many reports will be needed, when they will be required, who is going to contribute data, how many data will have to be stored for what length of time, and many other such details. A detailed plan for the flow of information must be worked out, and the forms used to input data, the handling procedures, and the timing must be adapted so that they will be appropriate for data processing. A computer system must be selected. Adequate documentation must be prepared to describe all the procedures. Personnel must be trained in the input behavior necessary to develop the system. Then the operation begins.

Once it is operating, field tests and upgrading of the management information system will continue, and it will be gradually extended to deal with other aspects of the organization.

C. How to use PPB based on Management Information Systems in educational systems. Though individual students, at the organism level of living systems, plan, program, and budget, their problems are not so complex that PPB is useful. The same is true of the classroom, at the group level, the next higher level of complexity. At the next higher level, the organization, and above, complexity is so great that PPB is potentially of great value. A school, providing secondary education to students in a given region, if it is relatively large, can profitably employ PPB. So can the next higher echelon, serving a whole town or city, a school system. A college, providing higher education, can, and so can a more complex university. At a higher echelon a state system of higher education can employ PPB. At any higher level--society or supratational system--it is in this modern age almost essential to efficient operation.

1. A school. A single school may be so small that it does not realistically justify a computerized management information system to implement PPB. A school of a thousand or more students, on the other hand, might make good use of it. In a school, the principle information needed involves a student data bank containing information about students, a comparable teacher data bank, a data bank about the curriculum and related materials, a data bank about rooms and other space in the school, and one about budget and other administrative

matters. Programs would also need to be written to manipulate and interrelate the data from these different sources and to enable a computer to print out such reports and charts as: Time schedules for each student; time schedules for each teacher and administrator; time schedules for each room in the school; lists of students for which each teacher is responsible in each class; budgets; accounts; schedules for use of various sorts of reports on short-range and long-range costs in money and student, teacher, and administrator time of all sorts of energy, information, and services used in the school; reports of grades; scores of achievement, personality, and intelligence; cost-effectiveness comparisons, employing various measures of cost and improvement in grades or scores on various tests as measures of effectiveness. The principal can compare various courses or programs against criteria of how well they accomplished the purposes of the school as viewed by teachers, principal, superintendent, or school board. Other alternative programs can be considered and decisions made, on all the available updated evidence, whether to initiate them in future years, or maintain or expand current programs.

Suppose that a principal were considering whether the physical education program of his school was meeting its fundamental purposes and immediate goals or whether it should be altered in some way. He might proceed to restate the purposes and goals as follows:

Purpose A: To develop physical skills and fitness to the extent of each pupil's ability. Specific Goal A: To achieve a mean score for our students in the top 25 percent on the physical fitness screening test of New York State.

Purpose B: To provide wide experience in sports to students, both as player and as leader. Specific Goal B: Each of our students to develop skill in three team and five individual sports or activities.

Purpose C: To develop the leadership attributes of courage, self-control, sportsmanship, aggressiveness, poise, and perseverance. Specific Goal C: Each student to advance, from the beginning of the school year to the end, 10 points on a leadership rating scale filled out by his fellow students.

Purpose D: To provide outlets for physical activity. Specific Goal D: Each student to take exercise a minimum of one half hour a day outside of school hours.

The principal might then list the major feasible alternative programs for achieving the purposes and goals of the physical education program. In this case they might be the following:

1. Continue the existing program, using resources at the current rate.
2. Continue the existing program and increase the rate at which resources are used.
3. Continue the existing program and increase the rate at which resources are used 20 percent.
4. Reduce rate of expenditure of resources for athletic contests with other schools 50 percent and allocate resources saved by this to other activities.
5. Reduce class activities 50 percent and allocate resources saved by this to intramural activities.

6. Eliminate intramural activities and athletic contests with other schools and increase the resources allocated to class activities by the amount saved by these reductions.

7. Eliminate intramural activities and athletic contest with other schools and allot the resources saved to corrective activities and activities for the physically underdeveloped.

The principal might then calculate the costs and potential benefits of each alternative program and on the basis of this evidence select one. In future years he would determine the actual costs and effectiveness--how well the specific goals were met--in deciding about whether to stick with the alternative selected or to switch to another program.[11]

2. A school system. The management information system for an entire school system would store many more data than one for a single school--enough more, in a large system, to justify use of a fairly large third generation computer in a time-sharing mode with remote terminals at each school and in the control office to transmit and receive data and interact with the computer. The data banks for the school system would contain much the same information as for a single school, but collected and constantly updated for all schools and programs in a uniform way. In addition the school system would have data banks on characteristics of the community,

demographic trends, political factors, and sources of grant funds, as well as more complex and sophisticated programs used to analyze the data for PPB and other purposes.

Such a system can prepare a budget by computer annually or more frequently, for the superintendent and school board. The budgetary data can be broken down not only in the traditional chart of accounts but according to programs, indicating for a program category like spelling or reading how much is spent in each school and in the whole school system. Each program can have associated with its cost measures its effectiveness evaluation measures. Each program can include a breakdown of funds and time allocated to it by any categories desired. Also comparisons can be made with previous years.

The automated system can also be used by the superintendent and his staff for planning purposes. Systems analyses can be carried out when new programs, new personnel, new materials, or changes of existing plans are proposed. Thus the proposer has available data to help analyze and defend why the alternate program he suggests will be an improvement in cost or effectiveness over the status quo. Furthermore, planning may be carried out for the next budget cycle at such key times as when contracts for teachers are negotiated for the following year. Analyses may be made at any time, by grade level, by school, by vendor, or by many other breakdowns. Accounting questions may be asked and answered

at frequent intervals--such as whether each responsible group is staying within its budget. If not, the management information system can assist the superintendent in deciding how funds can be reallocated to meet existing needs for the rest of the year. The system can provide for daily attendance reporting, and for scheduling of such resources as substitute teachers, substitute drivers, and extra equipment. The locating of children or teachers in emergencies is another important function for it. It can also maintain updated student, teacher, and employee health records and facilitate control of petty cash, and small funds.

An illustrative example of how PPB using such an automated management system can be carried out in a school system may be found in an analysis of a school busing program. First, criteria are set up to indicate how well the program's goals must be fulfilled. For instance, suppose the goal is to bus all students who live more than two miles from school. The criteria will define such needs as maximum allowable travel time for students, acceptable range of arrival times, and other factors.

The superintendent or school board that must make the decisions might have alternative busing programs evaluated within the framework of available resources and necessary constraints. Resources include such things as school budgets, personnel, existing facilities, future income, supportive attitudes of the school board, and so on. Constraints include the legal, federal, state, and

local situation, the attitudes prevalent in the school system, any negative mood of the school board, the demands of teacher unions, and other factors.

The output of this PPB analysis, as in all others, would be a set of alternatives, each with benefits listed and costs shown. The alternatives are evaluated, ranked and presented to the decision-maker who can then select a preferred set.

PPB requires multiyear planning. In a K-8 school system, several time spans can be considered for planning. Traditionally, organizations talk about 5 to 20 years when they talk about long-range planning. One can look at the existing population of preschool children who will be entering the school system, which suggests looking five years ahead. Or one can consider how long it takes for any decision started at the kindergarten level to ripple through the whole system. This suggests a nine-year planning span.

One possible set of programs for a K-8 school system appears below:

I. Administration

II. Instruction

- a. Social Studies
- b. Mathematics
- c. English
- d. Science
- e. Foreign Language

f. Arts and Crafts

g. Physical Education

h. Special Education, etc.

III. Teaching Aids

a. Audiovisual Aids

b. ETV

c. Miscellaneous, etc.

IV. Research and Development

a. Administration

b. Instruction

c. Teaching Aids

d. Supporting Activities

V. Supporting Activities

a. Library

b. Lunchroom

c. Building Operation

d. Maintenance

e. Transportation

VI. Miscellaneous

When constructing a program, it is important to accumulate under it all relevant activities. Major activities involve using facilities and other supports to achieve given goals. Some programs may continue through the life of the long-range plan, such as teaching English; others may be short-lived, like an experimental program designed to study speech disorders in order

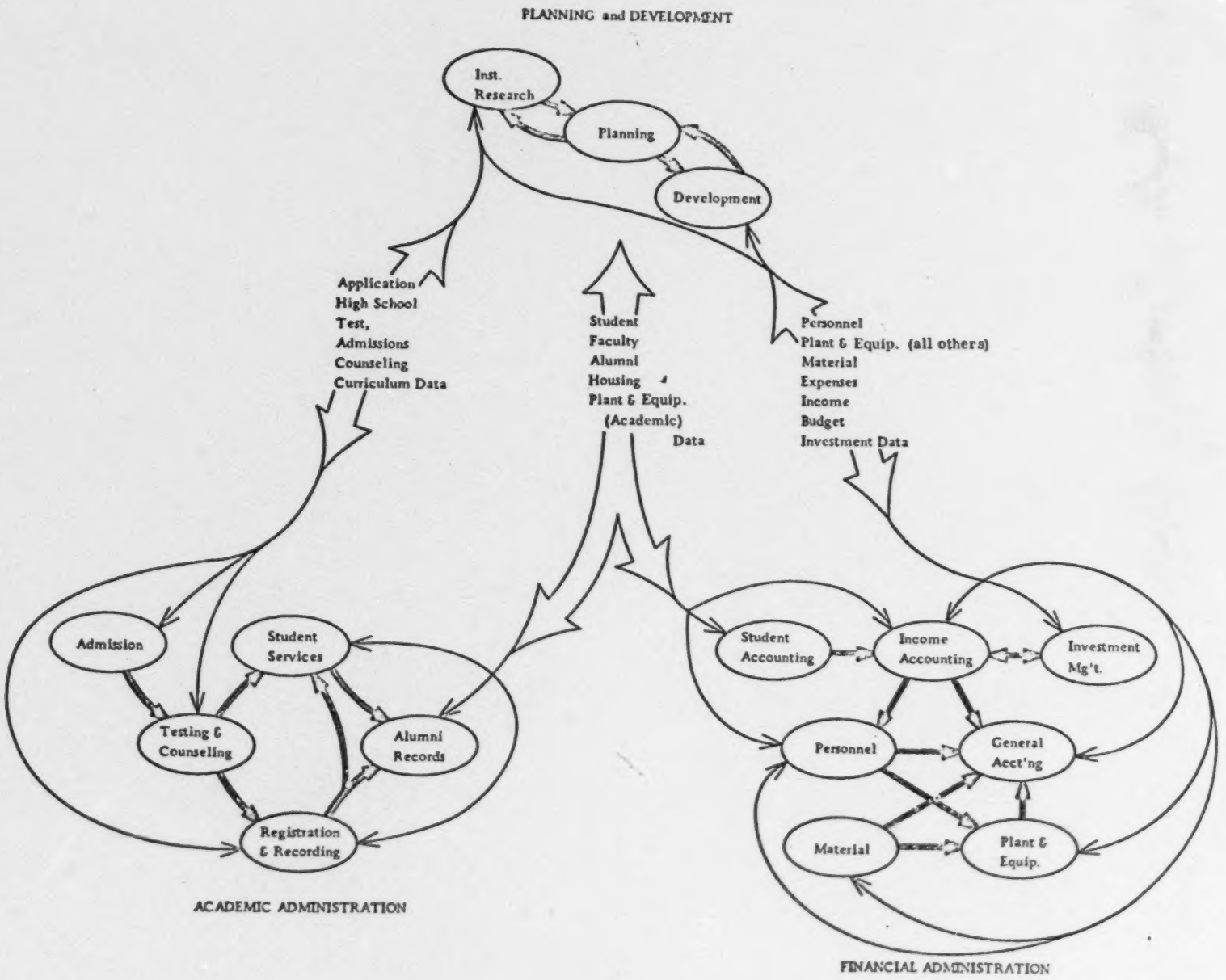
to recommend a plan for the entire school system.

Each program has outputs. Some programs will have neat goals that can be easily evaluated, while others will have objectives that are very difficult to evaluate or must be evaluated subjectively. It is not necessary, however, to wait until one has a certain quantitative set of objectives before starting the programming,

PPB must cover all costs and all parts of a school system. It does not make sense to have a program budget only for the English program or only for the building program while leaving out maintenance or any other costs. All costs and all parts of the educational system must be covered.[12]

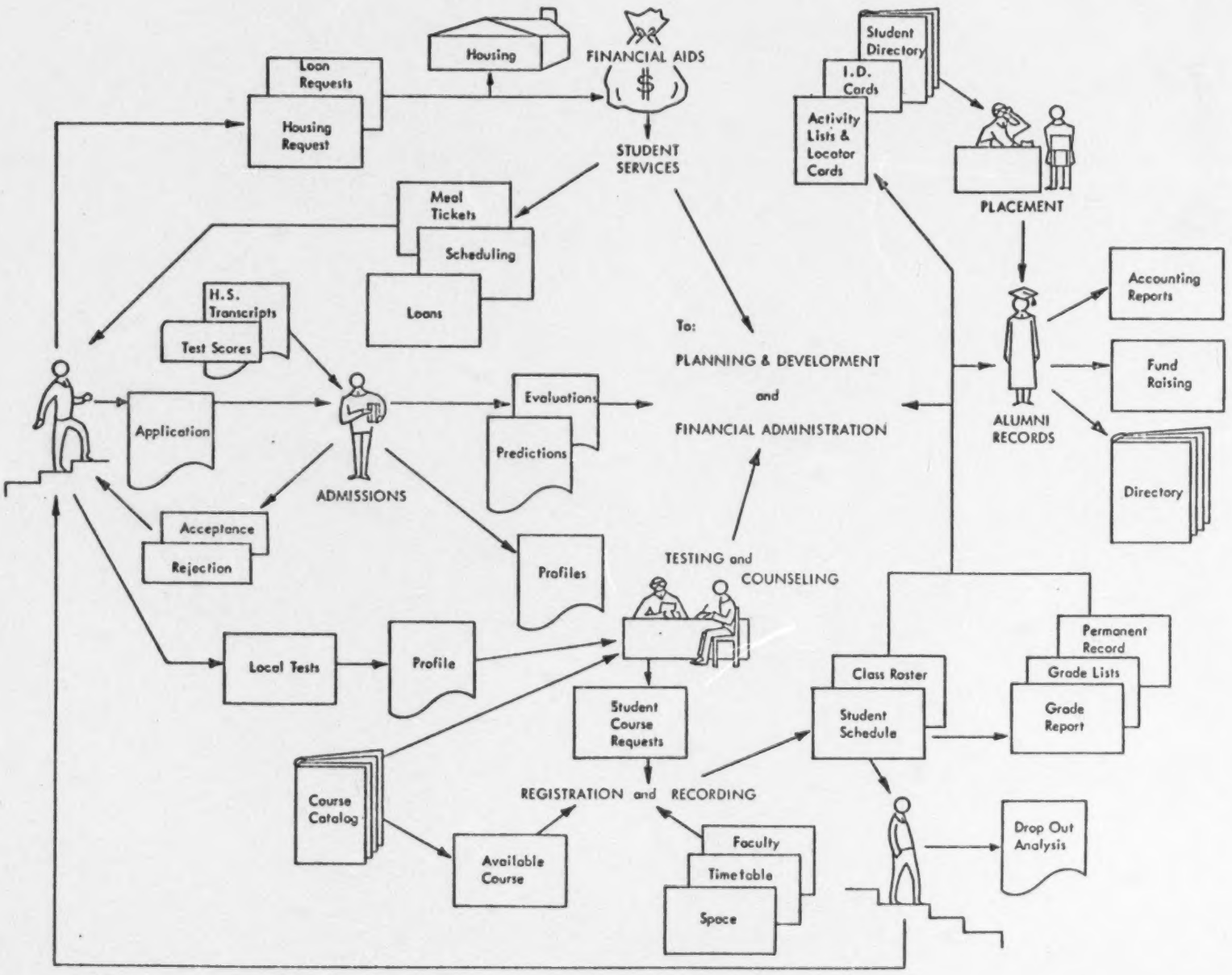
3. A college. An organization of the complexity and size of the average junior college or private college can profit significantly from a management information system, access to which is preferably available on-line by multiple remote terminals from which inputs to the system can be made, in order to update it, and outputs obtained to give information to various departments of the college and to aid them in their matter-energy and information processing activities.

The primary components of such an information system are data banks for academic administration (concerning students, alumni, and faculty--part of the personnel data bank), for financial administration (concerning personnel, accounting, investments, materials, plant and equipment), for institutional research, planning, and development. The interrelationships among these data banks, according to one plan, are indicated in the following figure:



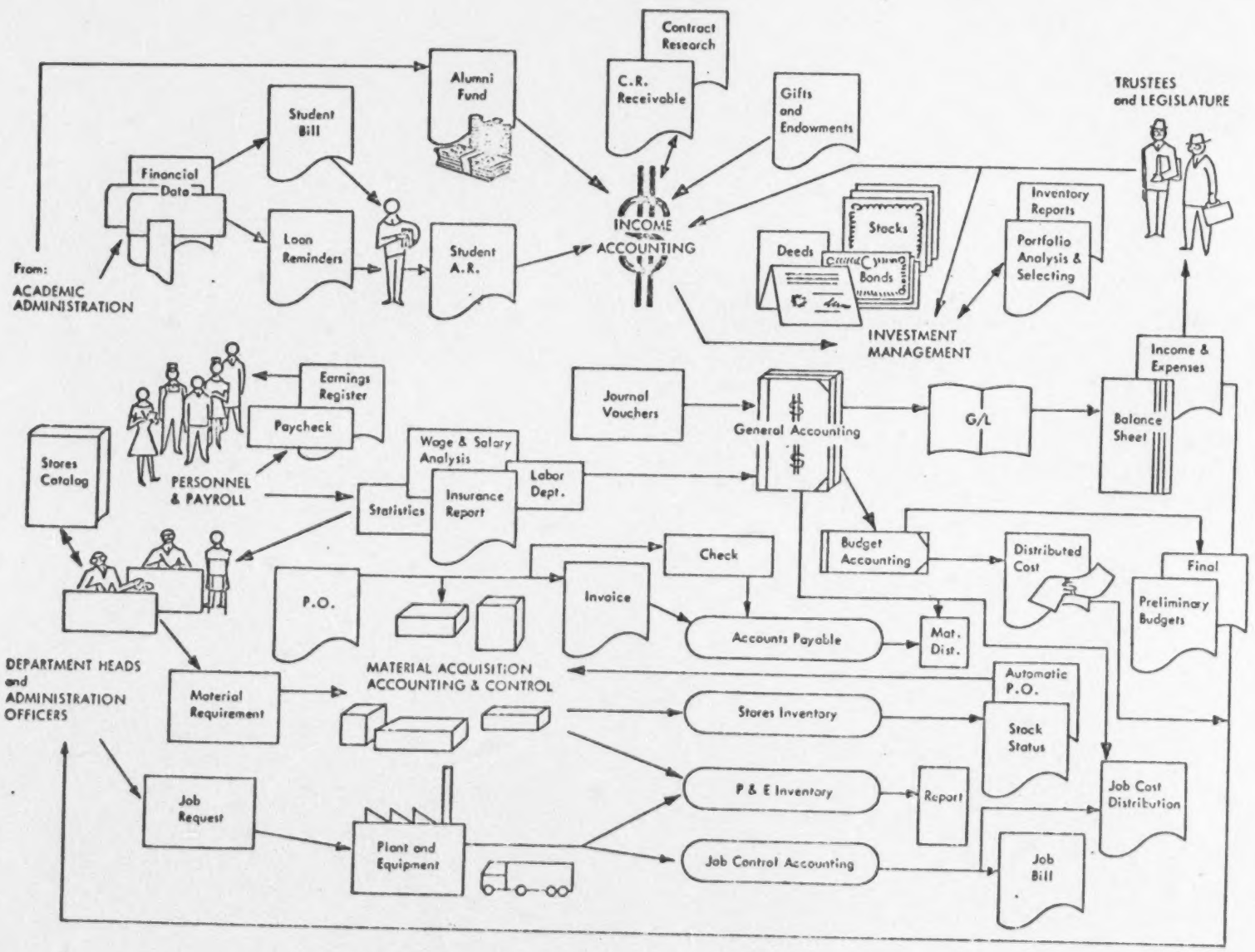
Data Interrelationships

There are many parts with different arrays of data in a part of the overall system above, the data bank for academic administration, which stores information for the academic units of the college. They are shown in the figure below.



Academic Administration Data Bank

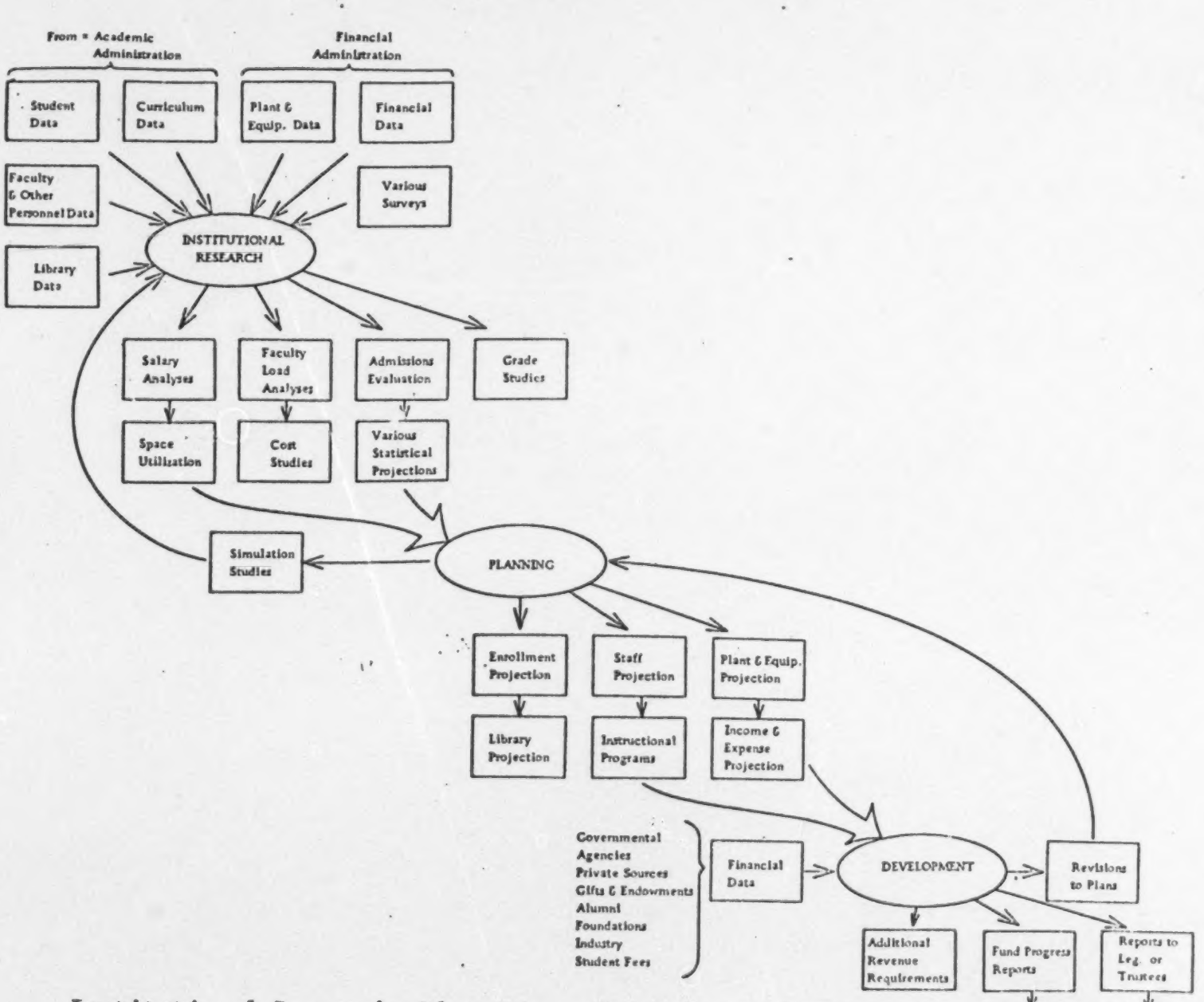
In this data bank is a master file of information about each student. Its collection begins when he applies for admission and continues until he graduates and even afterward when he is an alumnus. Information is included from the Admissions Office, from Testing and Counseling, from the Registrar's Office, from the faculty members who taught each student, from various offices which provide student services, and from the Alumni Office. Personnel data on the faculty and academic staff are also in this file. So are data on the effectiveness of faculty members, performance, such as how many students they teach, how much they publish--rough measures relevant to PPB cost effectiveness computations. The parts of the data bank for financial administration are shown in the figure below.



Financial Administration Data Bank

. In the financial administration data bank are components for student billing and accounting, including student loans, scholarships, fees, and tuition. Then there are the many sorts of information required for personnel files for academic and nonacademic personnel and payroll management. There are data on purchasing and inventorying of materials, for budgeting and accounting, and for investment management. Various measures of costs can be obtained from this data bank--some of the essential data for PPB.

The data banks for institutional research, planning, and development are pictured in the figure below.



Institutional Research, Planning, and Development Data Bank

These data banks contain much of the information relevant to PPB. A good deal of it is calculated by computer from the other data banks previously mentioned. Faculty loads, from student and faculty records; faculty costs, from faculty and budget records--both are measures of costs for cost-effectiveness computations. Examples of charts of such cost measures appear in the figure below.

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INSTITUTIONAL RESEARCH OFFICE

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10100	GRAVES, GLADYS	003461278	75	48	21	10	5	14	1	1	
10700	BARK, SHERMAN	001286934	100	27	59	4	0	6	0	4	
10700	CAN, CHARLES	098361249	100	31	19	37	2	1	8	2	
10700	MOX, JOHN	081274311	85	68	0	20	5	6	0	1	
10701	CURTIS, HELEN	043216858	100	51	16	18	4	6	4	1	
10701	LEWIS, JEAN	001231244	50	10	6	12	2	15	5	0	

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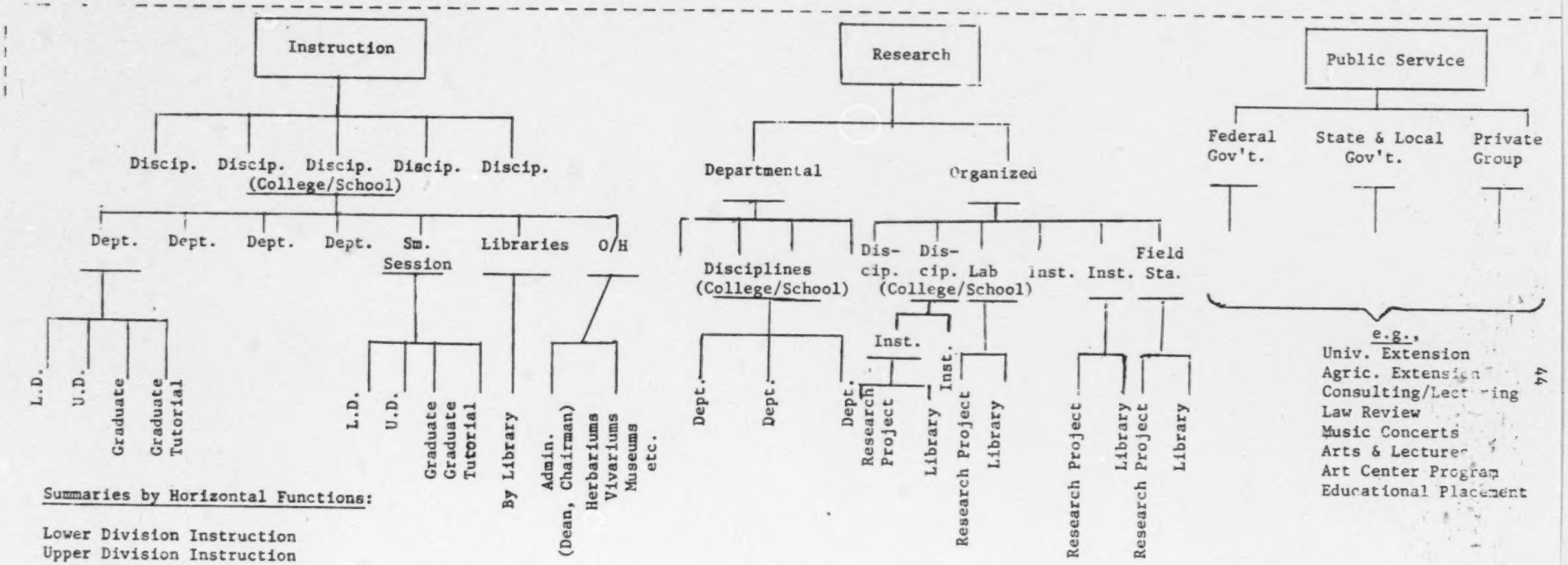
				%	AMOUNT	%	AMOUNT	%	AMOUNT	%	AMOUNT	%	AMOUNT	%	AMOUNT	%	AMOUNT
10068	003416875	100	8200.00	40	3280.00	10	820.00	10	820.00	2	164.00	0	0	20	1640.00	8	656.00
10068	086121145	100	9600.00	60	5760.00	8	768.00	20	1980.00	4	384.00	2	198.00	2	198.00	4	384.00
10068	089743582	75	7000.00	20	1400.00	60	4200.00	6	420.00	2	140.00	10	700.00	2	140.00	2	140.00
10075	004317682	100	10,200.00	35	3570.00	18	1836.00	16	1632.00	10	1020.00	10	1020.00	3	306.00	8	816.00

Faculty Load and Faculty Cost Distributions

Institutional research commonly investigates the comparative costs and effectivenesses by various measures of different programs in the college computer models and simulation techniques enable institutional researchers to investigate possible alternative programs quantitatively and to extrapolate program development into future years. They can put their findings before administrators as a basis for planning, setting up of development program goals, and other fundamental management decisions for the college.[13]

4. A university. Colleges are complicated institutions. Universities may be an order of magnitude or so more complex. The huge multiversities like the University of California and the State University of New York, each with well over 100,000 students, are so vast that they are almost out of management control. In such large organizations there are many degrees of freedom for program experimentation. Consequently sophisticated management methods properly applied, can result in important improvements in quality of educational functions and major savings in expenditures of money and time.

How a computerized management information system can be used for PPB in a large multicampus university can be illustrated by the following example. Fundamentally data banks are set up like those suggested above for a college. The task of establishing the data banks and keeping inputs to them current is, of course, much greater. University programs can be categorized as in the figures on the following two pages.



44

Primary Programs

Summaries by Horizontal Functions:

Lower Division Instruction
Upper Division Instruction
Graduate Instruction
Graduate Tutorial
Museums, etc.
Libraries
Institutes, etc.
Laboratories
Summer Sessions
Disciplines (College/School)

Libraries

Special Collections

Government Publications

Periodicals

General Administration

Chancellor's Office

Architects & Engineers

Accounting Office

Personnel Office

Admissions Office

Graduate Div. Office

Registrar's Office

Business Office

Academic Committees

Overhead

General Student Services

Dean of Students

Student Health Service

Counselling Center

Student/Alum. Placement

Aux. Enterprises:
- Student housing & feeding
- Intercoll. Athletics
- Parking System

Student Aid:
- Fellowships/Scholarships
- Loans
- Services

Supporting Programs

Notice that the above figure includes three primary programs and three supporting programs. The primary programs are directed to the three most commonly stated purposes of a university: instruction, research, and public service. Instruction is then broken down by disciplines (agriculture, biological sciences, engineering, etc.). Each discipline is divided into the following categories: departments, special programs like summer sessions, specialized libraries for specific fields, and overhead. The instruction in each department is further broken into lower division, upper division, graduate, and tutorial. Similarly, research and public service are disaggregated into their components. The three supporting programs are likewise divided into smaller subprograms and program elements.

The instructional program, thus analyzed for one program field on one campus of the university, prepared for PPB, is shown in the figure below. Multiyear extrapolation for ten years into the future derived from a complex model dealing with several organizational growth factors is also shown.[14] (See page 47 and 48.)

Complex simulations enable management personnel to investigate many alternative programs in terms of cost-effectiveness once data like this have been gathered and stored in computer memory.[15]

5. A state system of higher education. There may be little difference between a state multicampus university and a state system of higher education. The latter may also embrace state colleges, community or junior colleges, and various sorts

CAMPUS A - 1967 DATE 6/15/67

Major Program Instruction

Program Engineering

Program Element Lower Division

FISCAL YEARS

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Number Of Students In Major	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.
Total Student Credit Hours	630.0	660.0	690.0	720.0	750.0	780.0	810.0	840.0	870.0	900.
Total Weekly Student Hours	683.0	716.0	749.0	782.0	815.0	848.0	881.0	914.0	947.0	980.
Total Faculty Contact Hours	29.0	33.0	37.0	41.0	45.0	49.0	53.0	57.0	61.0	65.
Mean Class Size	23.6	21.7	20.2	19.1	18.1	17.3	16.6	16.0	15.5	15.
Academic FTE										
Dean	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.
Professor	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.
Associate Professor	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.
Assistant Professor	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.
Instructor	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.
Lecturer	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.
Associate	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.
Teaching Assistants	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.
Professional Researcher	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Librarian										
Other										
Total Academic FTE	4.7	4.7	4.8	4.9	4.9	5.0	5.1	5.1	5.2	5.
Non-Academic FTE										
Clerical, Technical & Agric.	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.
General Assistance	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.
Other										
Total Non-Academic FTE	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.
Total Instructional & Support Staff	8.0	8.3	8.7	9.1	9.4	9.8	10.2	10.5	10.9	11.

One Program Field (Engineering) on One Campus in the PPB of a Large University

CAMPUS A - 1967 DATE 6/15/67

Major Program Instruction

Program Engineering

Program Element Lower Division

	FISCAL YEARS									
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Research & Development Costs										
Initial Investment Costs										
Land										
Site Studies/Master Planning/ Site Clearance										
Utilities & Site Development										
Construction & Equipment										
Classrooms	7040	7080	7120	7160	7200	7240	7280	7320	7360	7400
Class Labs	1220	1240	1260	1280	1300	1320	1340	1360	1380	1400
Research & Office	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Other										
Total Initial Investments	10270	10340	10410	10480	10550	10620	10690	10760	10830	10900
Annual Operating Costs										
Salaries & Benefits										
Academic Personnel										
Teaching Salaries	54000	56000	58000	60000	62000	64000	66000	68000	70000	72000
Benefits	2117	2137	2157	2177	2197	2218	2238	2258	2278	2298
Research Salaries	0	0	0	0	0	0	0	0	0	0
Benefits	0	0	0	0	0	0	0	0	0	0
Other Salaries										
Benefits										
Non-Academic										
Clerical, Technical & Agric.	12720	13483	14292	15150	16059	17022	18044	19126	20274	21490
Benefits	1056	1152	1248	1344	1440	1536	1632	1728	1824	1920
Other Salaries	4240	4494	4764	5050	5353	5674	6015	6375	6758	7163
Benefits	528	576	624	672	720	768	816	864	912	960
Total Salaries	70960	73978	77056	80200	83412	86696	90058	93502	97032	100654
Total Benefits	3701	3865	4029	4193	4357	4522	4886	4850	5014	5178

of technical institutes and specialized professional schools. The latter may be more decentralized in administration, each campus having more autonomy. But not necessarily so.

In recent months increased attention has been devoted to the establishment of management information systems and use of PPB in state systems of higher education. The following example is a brief description of such an aid to statewide management which is currently in operation.[16] This procedure deals with data concerning four major aspects of any statewide system of higher education: student enrollment, staffing, physical plant, and finances.

Information inputs in the form of regular, standard reports are introduced into the system by each of the state-assisted institutions of higher education. Computerized analytical routines manipulate these inputs for two purposes, public information and resource analysis by management personnel.

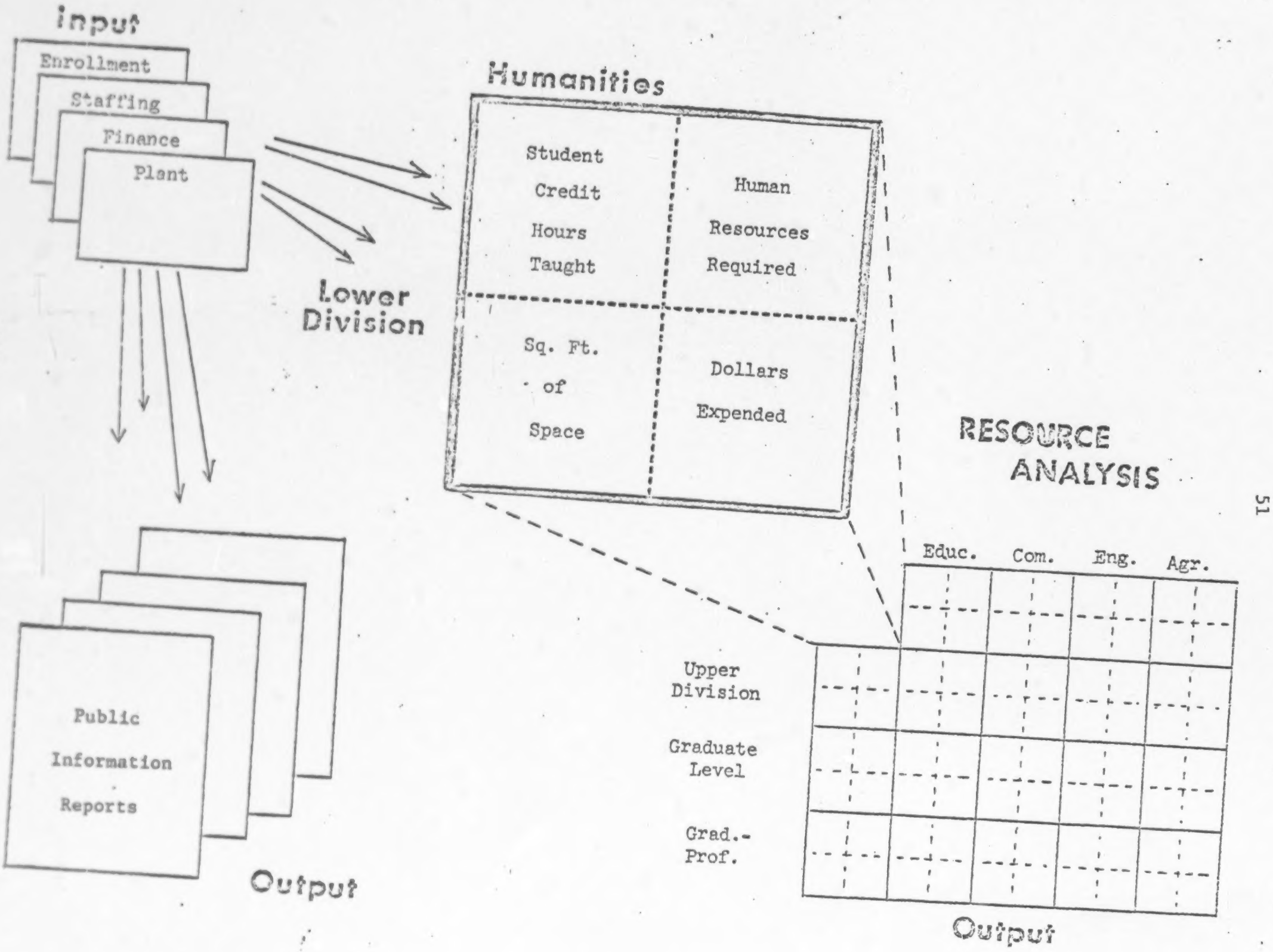
For public information data are analyzed as follows: In the student enrollment area, such facts are determined as the age, sex, and marital status of the students, where they come from, what student ranks they hold, what their major academic interests are, and what enrollment loads they carry. In the physical plant area, the facts concern how many buildings, rooms, and student stations each of the institutions has, how many hours each day these facilities are actually used, and the physical condition

of each building. In the staffing and finances areas, selected operating facts are collected and comparisons among institutions made within each area.

Resource analysis is concerned with how all of the facts collected within the four major areas of operation relate to each other in the actual functioning of a given college or university. Just how do the staffing, physical plant, and financial resources actually contribute to the support of instructional activities in various academic program areas and at various levels of teaching?

As is illustrated in the figure on page 51, resource analysis involves the establishment of a series of standard academic program categories, and within each category several standard levels of instructional courses. Through a sequence of allocation procedures, the various human, physical, and financial resources of the college or university are then "charged" against the program they support. By studying the relative rates at which various teaching programs and instructional course levels utilize an institution's resources, one should be able to learn a good deal about present and future needs of existing and yet-to-be founded institutions of higher education.

Data processing for resource analysis shows, for each institution in the state system: How many FTE students by rank were enrolled at each level of each program; how many FTE faculty members by rank were required at each level of each program; how all of the space available to the entire institution was used



RESOURCE ANALYSIS

and how much instructional space was used by each level and each program; and the expenditures by the institution which related to the instructional process. It is necessary to allocate all expenditures in some meaningful way to each unit of instruction. By using enrollment, faculty staffing, and space data one can develop indices which serve to allocate certain expenditures. For instance, expenditures for maintaining various buildings constitute part of the cost of a given unit of instruction, the expense being roughly proportional to its use of available classroom space. Consequently an index of classroom utilization is developed, allocating a fraction of plant expenditures to each unit of instruction. Similarly all other expenditures (such as those for administration, public service, etc.) are allocated to specific units of instruction.

The first step in resource analysis is to load the data banks. For four academic programs [two fields (English and Music) at two levels, lower division (freshman-sophomore) and upper division (junior-senior)], the data bank would look like the example in the following figure.

1. Primary Data Bank (requires four records to accommodate two programs each at two levels)

	Record(1)	Record(2)	Record(3)	Record(4)
Program Number	14	14	10	10
Level	1	2	1	2
Institution Number	00	00	00	00
Institution Calendar	2	2	2	2
*Faculty Count	7.0	6.0	7.3	8.0
Faculty Salary	23,333	21,333	34,333	28,333
*Student Count	106.7	61.7	216.7	163.3
**Total Space	3,000	1,000	3,000	2,000
Augmented Space	3,201	1,028	3,249	2,178

2. Space Data Record (one only)

Instructional Space	9,000
Student Services Space	3,000
Public Services Space	3,000
Institution Number	00

3. Financial Data Record
Institutional Expenditures and Transfers (one only)

Departmental Instruction and Research	155,000
Plant Operation and Maintenance	20,000
Student Services	10,000
Public Services	15,000
Institution Number	00

4. Program Expenditures (two records to accommodate two programs)

	Record(1)	Record(2)
Faculty Salaries	45,000	65,000
Other Salaries	10,000	15,000
Other Expenditures	10,000	10,000
Program Code	14	10
Institution Number	00	00

*Breakdown by rank is not shown in this example.

**Breakdown by classroom, laboratory and other space is not considered in this example.

Contents of the Data Bank

Once information is stored in the data bank in the form in which it was summarized from institutional reports, the next step is to allocate all costs to specific units of instruction. Four indices are developed: enrollment, faculty, space, and the student services index. These indices represent the portion of total enrollment attributable to each level of each program, the portion of faculty salaries attributable to each level of each program, the portion of total instructional space used by each level of program, and, weighting graduate students one and undergraduate students two, the portion of total enrollment attributable to each level of each program. An example appears in the figure below:

Enrollment		Students	Fraction
Lower Division English		106.7	.195
Upper Division English		61.7	.112
Lower Division Music		216.7	.395
Upper Division Music		163.3	.298
	Total	548.4	1.000

Faculty		Salary	Fraction
Lower Division English		23,333	.217
Upper Division English		21,333	.199
Lower Division Music		34,333	.320
Upper Division Music		28,333	.264
	Total	107,332	1.000

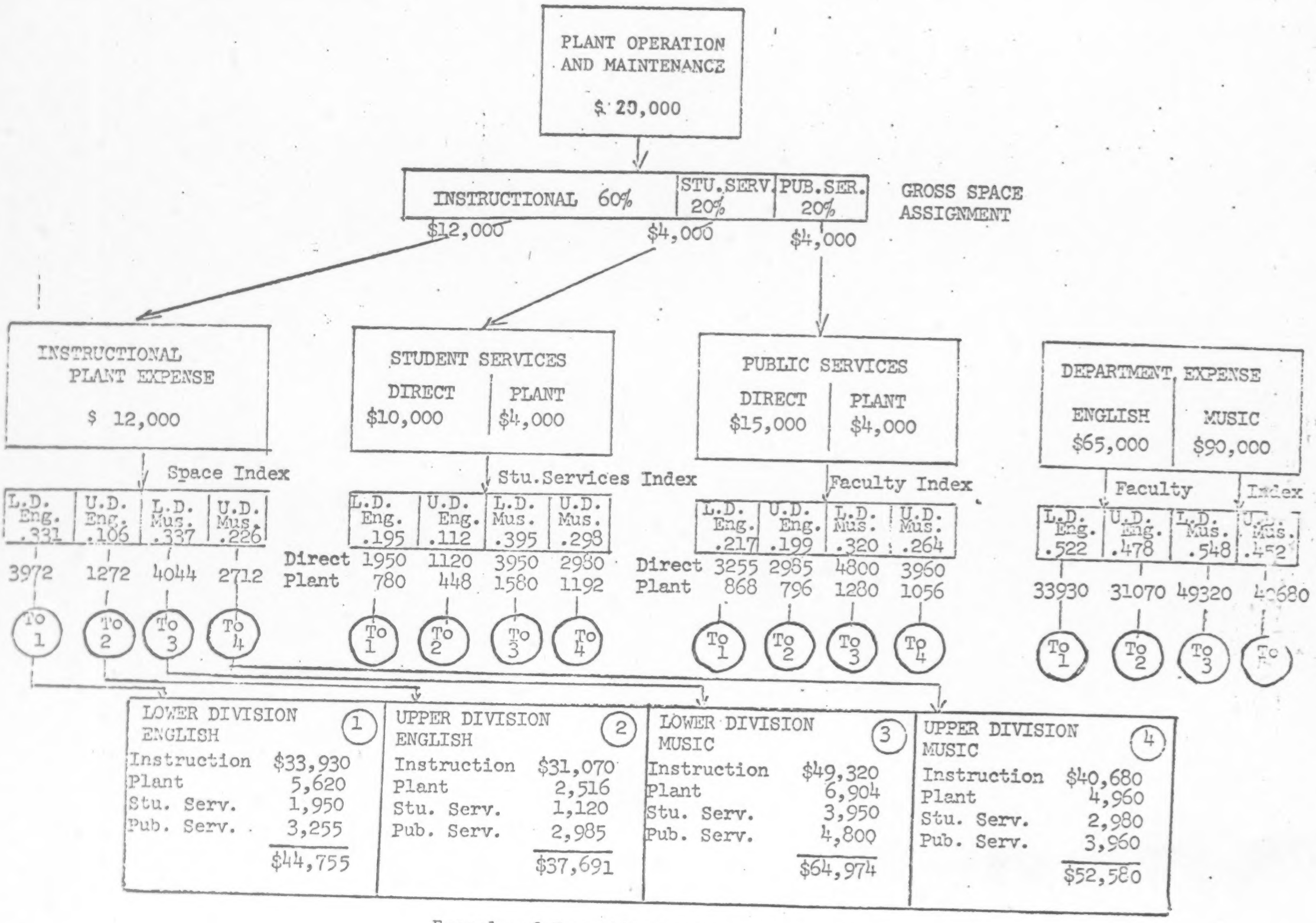
Space		Area	Fraction
Lower Division English		3201	.331
Upper Division English		1028	.106
Lower Division Music		3249	.337
Upper Division Music		2178	.226
	Total	9656	1.000

Student Services

Since no graduate students appear in this example, the index is the same as the enrollment index.

Enrollment, Faculty, Space, and Student Services Indices

Expenditures of all sorts are then allocated to each program in proportion to the above indices. An example is given in the figure on the next page.



Example of Expenditure Allocation Procedure

When the allocation of expenditures is finished, the primary record in the data bank is complete (See figure below.) Many reports can be developed from these data.

1. Primary Data Bank

	Record (1)	Record (2)	Record (3)	Record (4)
Program No.	14	14	10	10
Level	1	2	1	2
Institution	00	00	00	00
Inst. Cal.	2	2	2	2
*Faculty Count	7.0	6.0	7.3	8.0
Faculty Salary	23,333	21,333	34,333	28,333
*Student Count	106.7	61.7	216.7	163.3
**Total Space	3,000	1,000	3,000	2,000
Augmented Space	3,201	1,028	3,249	2,178
Enrollment Index	.195	.112	.395	.298
Faculty Index	.217	.199	.320	.264
Student Services Index	.195	.112	.395	.298
Space Index	.331	.106	.337	.226
Faculty Salaries	23,490	21,510	35,620	29,380
Other Salaries	5,220	4,780	8,220	6,780
Other Expenditures	5,220	4,780	5,480	4,520
Total Instruc. Cost	33,930	31,070	49,320	40,680
Public Services	3,255	2,985	4,800	3,960
Plant Operation	5,620	2,516	6,904	4,960
Student Services	1,950	1,120	3,950	2,980

*Breakdown by rank is not shown in this example.
** Breakdown by classroom, laboratory, and other space is not considered in this example.

Example of Data in Data Bank Relevant to Four Programs

These data can be manipulated in many ways, including computer simulation methods which examine alternative programs, for cost-effectiveness analyses and PPB.

6. A national educational system. In some countries the educational institutions operate with a great deal of local autonomy, as in the United States. In others they are under

much more centralized control, as in the Soviet Union. In either case it is possible to collect management data for public information and resource analysis. This information can serve as a basis for policy formation, legislation, and financial grants, if not for direct management control. The United States Office of Education, relying on voluntary cooperation by the states, is collecting such standardized information from them. It could be used for PPB.

7. International education. Some management information flows among the countries of the world, coordinated by UNESCO. Educators meet in international congresses to discuss the higher education policies of their countries. As of now, however, only desultory examples of international cooperation in this field exist. It would be entirely feasible to use management information systems and to apply PPB to international educational programs if they should ever be established.

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12. The preceding example of PPB for a school system is based on Rath, G. J. PPBS is more than a budget: it's a total planning process. Nation's Schools, 1968, 82, No. 5, 51-60.

13. The preceding example of an automated management information system and PPB for a college is based on College and university administrative applications, IBM, Technical Publications Department, 1968.

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16. Cf. Ohio Board of Regents. Uniform Information System. Resource analysis procedures. Columbus, 1968.